MEG実験2008 陽電子スペクトロメータ

西口 創／KEK素核研，他 MEG コラボレーション

**JPS Spring Meeting, 27-30/Mar./2009, Rikkyo University**
contents

- MEG e⁺ spectrometer
- MEG Drift Chamber
- Run2007 and Run2008
- Problems
- Prospects
- Conclusion
Requirements for Positron Spectrometer

* **Very high counting rate**
  * the most intense DC muon beam in the world
  * muon stopping rate: \(3 \times 10^7\) muon/\(\text{sec}\)

* **Good momentum/position/timing resolution**
  * aiming excellent sensitivity
  * <1\% momentum resolution, 500\(\mu\)m position resolution for both direction (r, z) and 40 ps timing resolution

* **Low-mass material**
  * 52.8MeV/c positron can be affected by multiple Coulomb scattering easily
  * \(\gamma\) background generation should be suppressed as much as possible
MEG Positron Spectrometer

**Solenoid**
- superconducting solenoid gradient B-field (0.5-1.7 T)
- very thin conductor and cryostat wall (0.2X₀)

**Drift Chamber**
- segmented radially (16 sectors)
- helium:ethane (50:50)
- opened-frame
- very thin cathode foil with pads

**Timing Counter**
- 2-layers of scintillators
  - scintillator bars (outer)
  - scintillator fibres (inner)

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Hajime NISHIGUCHI (KEK)  "MEG2008 Positron Spectrometer"  JPS-Spring-Meeting, 27-30/Mar./2009, Rikkyo University
MEG Drift Chamber

muon stopping target

Helium filled inside solenoid

Opened-frame structure

Helium based gas

Extremely thin cathode foil

Reduced readout electronics

Radial segmented DC modules
Engineering Run 2007

* (1) DAQ Check, (2) Conditioning with Final Beam Intensity, (3) Establish the Slow Control, (4) Establish the Calibration Procedure

* Major Problems:
  * **Discharge**: by helium
  * **Disconnection**: at patch panel of end cap

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<thead>
<tr>
<th></th>
<th>track finding eff.</th>
<th>good tracking eff.</th>
<th>mom. resolution</th>
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<tbody>
<tr>
<td>Run 2007</td>
<td>85%</td>
<td>65.2%</td>
<td>0.9%</td>
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<td>MC (full spec)</td>
<td>99%</td>
<td>97.5%</td>
<td>0.4-0.6%</td>
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<td>Month</td>
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<td>October</td>
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# MEG DC Summary 2008

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# of operational plane
32  28  27  24  21  18
Momentum Spectrum (Michel, 2008)

Reconstructed Spectrum (Michel + TC Trig.)

Entries/250keV (350k trig.)

Momentum (MeV/c)

PHYSICS RUN EVE. (JULY 2008)
How has it been degrading ...

• HV is applied to each plane individually.
• Finally, 18 planes were operational, only 12 planes were working with nominal voltage...
• With tight cut, resolution deterioration is saturated.
• But, efficiency has been degrading dramatically...
Momentum Spectrum (MEG, 2008)

Mom-Resolution is worse than 2007, due to missing planes, air doping, baseline noise.
Resolution Deterioration is saturated with tight cut. (~800keV/c)
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Momentum Spectrum, continued

Resolution Deterioration is saturated with tight cut. (~800keV/c)
Spectrometer Efficiency

Efficiency vs. week

- X-axis: week
- Y-axis: Efficiency

Hajime NISHIGUCHI (KEK)

“MEG2008 Positron Spectrometer”

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Discharges

- Inside COBRA is filled with pure helium, then DC-outside is exposed in helium atmosphere.
- HV-tracer-line is partially naked to helium in 2007, then discharged...
- We made the protection for helium in 2008 maintenance period, but...
Discharges

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* HV-tracer-line is partially naked to helium in 2007, then discharged...

* We made the protection for helium in 2008 maintenance period, but...
Discharge Studies

- More effective discharge protection is being developed in lab.
- Test Bench with helium, many protection ways are investigated.
- In parallel to that, investigation of actual module is underway.
- Final protection scheme is recently almost fixing.
Discharge Signature

- DC modules were uninstalled from COBRA solenoid, and is operating in Helium hat in lab.
- Each modules are under investigation.
- We found several discharge signature and candidates of the weak point.
Plan to Re-assemble

• Fix the protection scheme ASAP, then rebuild the first module in April.
• Start the long-term test in helium hat by the first module. In parallel, start reassemble all modules (incl. 5 spares).
  • Open module, Unmount the PCB boards, Install the new PCB, re-wire, and assemble again.
• Reassembling will continue by ~August.
• DC-activity Test will be performed in parallel to assembly.

• Aiming to reinstall/ready everything in beginning of September.
Conclusions

- MEG Positron Spectrometer ran for the first long-term experiment 2008.
- Unfortunately, several problems happened during the physics run, in particular, HV discharge problem.
- Due to discharge, DC system was operational partially, and thus the spectrometer performance was limited.
- Resolution deterioration was saturated, reconstruction efficiency was degrading continuously.
- Discharge study is finishing; now we are fixing the protection design.
- ALL DC will be reassembled in April-August.
- First DC module will be built ASAP, and long term test will be carried out in lab to confirm the new protection scheme.
- Spectrometer will be ready in September for the next physics run.
backups
Signature and Backgrounds

• **Signal**
  - $E_e = E_\gamma = m_\mu/2 = 52.8\text{MeV}$
  - $\theta = 180\text{deg}$.
  - time coincidence

  Clear 2-body kinematics
  use $\mu^+$ to avoid capture inside stopping target
  Background dominated by Accidental overlap
  - lower muon beam rate is better
  - DC muon beam is the best

• **Background**
  - radiative muon decay
  - accidental overlap
COBRA Solenoid

uniform B

graded B

low energy $e^+$ quickly swept out

constant bending radius independent of emission angles
Hit Rate in COBRA

![Graph showing hit rate in COBRA]

- **Uniform B-field**
- **COBRA B-field**

**Rate (Hz/cm²)**

- $10^5$
- $10^4$
- $10^3$
- $10^2$
- $10$

**Radius (cm)**

- 0
- 5
- 10
- 15
- 20
- 25
- 30

**DC region**
MEG Drift Chamber

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